SPECTROSCOPIC DETERMINATION OF THE ELECTROSTATIC POTENTIAL PROFILE IN A PLASMA PREFILLED ION DIODE

Abstract only

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The electrostatic potential profile in the acceleration region of a plasma prefilled magnetically insulated ion diode (MID) has been determined using laser induced fluorescence (LIF). The plasma is generated by the electrical breakdown of an argon gas puff in the interior of the ion diode anode (prior to the application of the diode high voltage). The plasma prefill density ranges from 10^{12} - 10^{14} cm^{-3} as determined from the absolute light intensity of the 4806Å line of Ar^+ (assuming a coronal equilibrium model). The plasma temperature, obtained using Ar^+ line intensity ratios, ranges from 1.5 to 3.5 eV. A 6 cm $\times$ 10 cm Ar^+ ion beam is extracted from the MID by the application of a 320 - 400 kV, 80 ns pulse from a 10 Ω pulsed power generator. Beam current densities as high as 55 A/cm^2 and beam purity as high as 90% (determined by time of flight measurements) have been obtained.

The electrostatic potential, Φ, as a function of distance from the anode, x, has been inferred from measurement of the velocity of the ions as a function of distance from the anode, $v(x)$, with the equation $\Phi(x) = -\frac{1}{2}m\left[v(x)\right]^2$. The velocity has been determined from the Doppler shift for resonant absorption of the 4401Å Ar^+ line using LIF. $\Phi(x)$ profiles have been obtained with varied plasma

prefill density and for diode configurations with and without electron emitting "vanes" on the cathode. In all cases a wide region adjacent to the anode (as much as 8 mm out of 11.5 mm hardware gap) is at anode potential (i.e. the acceleration occurs in a region as small as 3.5 mm adjacent to the cathode). In time dependent measurements of $\Phi(x)$ the dynamic acceleration region is observed to expand towards the anode. With no vanes on the cathode (a planar diode gap), the observed $\Phi(x)$ profile is clearly inconsistent with simple analytic models for planar MID's, but is consistent with the assumption of uniform electron density between the cathode and the anode plasma surface. The $\Phi(x)$ profiles obtained with an electron emitting vane on the cathode do not agree with the predictions of a particle in cell computer simulation performed for a similar geometry.